GENERAL

right triangle word problems with solutions and answers

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Right Triangle Word Problems with Solutions and Answers: A Complete Guide

When it comes to mastering geometry, few concepts are as essential—or as challenging—as the right triangle. Whether you're a student tackling a math test, a teacher preparing a lesson, or a curious learner exploring real world applications, understanding how to solve right triangle word problems is a valuable skill. In this guide, we'll walk through the fundamentals, give you a variety of practice problems, and show you step by step solutions. By the end, you'll be confident tackling any right triangle challenge that comes your way.

Why Right Triangle Word Problems Matter

Right triangle problems appear across many disciplines: architecture, engineering, physics, navigation, and even everyday tasks like building a shed or measuring a roof. They test your ability to apply the Pythagorean theorem, trigonometric ratios, and algebraic manipulation in practical contexts. Mastering these problems helps you develop:

- Logical reasoning and problem solving skills
- Proficiency with algebraic expressions and equations
- An intuitive sense for geometry and spatial relationships
- Confidence in applying math to real world scenarios

Key Concepts Every Right Triangle Problem Requires

The Pythagorean Theorem

The backbone of right triangle problems is the Pythagorean theorem: **$a^2 + b^2 = c^2$**, where **a** and **b** are the legs (the two sides that form the right angle) and **c**is the hypotenuse (the side opposite the right angle). This formula lets you find any missing side if the other two are known.

Trigonometric Ratios

When angles are given (or when you need to find an angle), the sine, cosine, and tangent ratios come into play:

- sin /;, óÒ ö÷ ÷6—FRö€ypotenuse
- cos /;, óÒ ö F¦ 6VçBö€ypotenuse
- tan /;, óÒ ö÷ ÷6—FRö F¦ 6Vç@

These relationships help you solve for unknown angles or sides when one side and an angle are known.

Algebraic Manipulation

Real world problems often involve additional variables or equations. Being comfortable moving terms around, factoring, and simplifying expressions is essential to keep the solution process clear and accurate.

Step by Step Strategy for Solving Right Triangle Word Problems

1. Read Carefully – Identify the known sides, angles, and what is being asked.
2. Draw a Diagram – Sketch the triangle, label all known values, and mark the right angle.

3. Choose the Right Formula – Decide whether you need the Pythagorean theorem, a trigonometric ratio, or both.
4. Set Up the Equation – Write the formula with the known values plugged in.
5. Solve Algebraically – Perform the necessary calculations to isolate the unknown.
6. Check Units and Reasonableness – Ensure the answer makes sense in context.
7. Write the Final Answer Clearly – State the result, including units if applicable.

Example Problem Set 1: Classic Pythagorean Applications

Below are five classic right triangle word problems. Each problem is followed by a detailed solution and the final answer.

Problem 1: Ladder Against the Wall

A 12 foot ladder leans against a wall. If the base of the ladder is 5 feet from the wall, how far up the wall does the ladder reach?

Solution:

1. Let the height on the wall be h.
2. Apply the Pythagorean theorem: $h^2 + 5^2 = 12^2$.
3. Compute: $h^2 + 25 = 144$.
4. Subtract 25: $h^2 = 119$.
5. Take the square root: h = " 119 "H 10.91 feet.

Answer: The ladder reaches approximately 10.91 feet up the wall.

Problem 2: Skyscraper Observation Deck

The observation deck of a skyscraper is 250 meters above ground. A tourist stands 40 meters away from the building's base. How far does the tourist have to climb a ladder to reach the deck?

Solution:

1. The ladder forms the hypotenuse of a right triangle with the height 250 /m and base 40 /m.
2. Use the Pythagorean theorem: $c^2 = 250^2 + 40^2$.
3. Compute: $c^2 = 62{,}500 + 1{,}600 = 64{,}100$.
4. Take the square root: c = " 64,100 "H 253.19 meters.

Answer: The ladder must be approximately 253.19 meters long.

Problem 3: Building a Roof

A roof has a pitch of 30° (the angle between the roof surface and the horizontal). The horizontal span of the roof is 20 feet. Find the vertical rise of the roof.

Solution:

1. Use the tangent ratio: tan /;, Ò ÷ ÷6—FRö F¦ 6VçBà
2. Plug in values: tan /30° = rise / 20.
3. Calculate tan /30° "H 0.577.
4. Multiply: rise = 0.577 × 20 "H 11.54 feet.

Answer: The roof rises about 11.54 feet.

Problem 4: Catapult Launch

A catapult launches a projectile horizontally from a 15 meter high platform. The projectile lands 60 meters away from the base of the platform. What is the launch angle if the projectile's initial speed is 30 /m/s?

Solution:

1. Determine the horizontal distance (range) is 60 /m.
2. Time of flight t = distance / horizontal speed = 60 / 30 = 2 /s.
3. Vertical motion: y = v € /sin /;, ÷B ² Ò ör ÷K" ‡v—F, r $, 'ã, öÒ÷;"'à
4. We know the platform height is 15 /m, so the projectile lands 15 /m lower: y = -15 /m.
5. Plug values: -15 = 30 /sin /;, ò*ƒ*"' Ò Ò ò*ƒ*'ã,'*ƒ*"›"à
6. Simplify: -15 = 60 /sin /;, Ò 'ãbà
7. Add 19.6: 4.6 = 60 /sin /;,à
8. Divide: sin /;, Ò ã scrà
9. Find ;*ƒ* ;, $, BãK à

Answer: The launch angle is approximately 4.4 degrees.

Problem 5: Bridge Construction

A bridge spans a river 180 meters wide. The bridge deck is 10 meters above the water. How long is the bridge's support beam that runs from the riverbank to the bridge deck?

Solution:

1. Consider a right triangle with base 180 /m and height 10 /m.
2. Apply the Pythagorean theorem: $c^2 = 180^2 + 10^2 = 32{,}400 + 100 = 32{,}500$.
3. Take the square root: c = " 32,500 "H 180.28 meters.

Answer: The support beam is approximately 180.28 meters long.

Example Problem Set 2: Mixed Geometry & Trigonometry

Problem 6: Hiking Trail

A hiker climbs a hill that rises 120 meters over a horizontal distance of 200 meters. What is the slope of the hill in degrees?

Solution:

1. Use tangent: tan /;, Ò ise / run = 120 / 200 = 0.6.
2. Find ;*ƒ* ;, Ò &7F â*ƒ* ãb' $, 3 ã"k à

Answer: The hill's slope is about 30.96 degrees.

Problem 7: Lighthouse Beam

A lighthouse emits a beam that illuminates a spot on the shoreline 500 meters away. The lighthouse is 80 meters above sea level. How far above sea level is the point on the shore where the beam hits?

Solution:

1. Consider a right triangle with horizontal leg 500 /m and vertical leg unknown h.
2. The lighthouse height (80 /m) is the vertical leg of a smaller right triangle that shares the same angle.
3. Use similar triangles: h / 500 = 80 / 0—but we need the angle first.
4. Compute the angle: tan /;, Ò *ƒ* ò S Ò ã b " ¸ "H 9.09°.
5. Now find the vertical height of the beam's spot: h = 500 /tan /;, Ò S ýr ó ã b Ò *ƒ* öÒà

6. Since the beam is horizontal, it remains at the same height as the lighthouse: 80 /m.

Answer: The beam hits the shoreline at 80 meters above sea level.

Problem 8: Satellite Dish Alignment

A satellite dish is mounted on a pole that is 25 feet tall. The dish is positioned 40 feet horizontally from the pole. If the dish must be tilted 20° above the horizontal to align with a satellite, what is the length of the rod that connects the dish to the pole?

Solution:

1. Model the rod as the hypotenuse of a right triangle with vertical leg 25 /ft and angle 20°.
2. Use cos /;, Ò F¦ 6VçB ò €ypotenuse !’ hypotenuse = adjacent / cos /;,à
3. Compute: cos /20° "H 0.9397.
4. Find rod length: rod = 25 / 0.9397 "H 26.63 feet.

Answer: The rod should be about 26.63 feet long.

Problem 9: Bridge Arch

A bridge arch has a radius of 30 meters. The arch rises 15 meters above the deck. How far from the deck to the base of the arch (the chord length) is the arch’s width?

Solution

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